CLAIMS

1. A nano-manipulator comprising

a first and a second beam anchored to a support in at least one point,

first and second manipulator means held by the first and second beam respectively, said manipulator means being formed by induced growth with a focused particle beam,

the first and/or the second beam being flexible between at least a first and a second relative position, wherein a distance between the first and second manipulator means in the first and the second position are different, and

means for applying an actuation force to the first and/or the second beam for moving the first and/or the second beam between the first and the second position.

2. A nano-manipulator according to claim 1, wherein the means for applying an actuation force are adapted to apply an electrostatic force to the first and second beams.

3. A nano-manipulator according to claim 1, wherein the means for applying an actuation force comprises

a plurality of actuator beams anchored to the support in at least one point, the plurality of actuator beams being adapted to apply an actuation force to the first and second beams, and

a control circuit for controlling actuation forces applied by the plurality of actuator beams to the first and second beams.

4. A nano-manipulator according to claim 3, wherein the actuation beams are adapted to apply a force to the first and second beams, the force being chosen from the group comprising electrostatic forces, piezoeresistive forces, piezoelectric forces, ferroelectric forces, ferromagnetic forces, thermoelectric forces, electromagnetic forces, etc.

5. A nano-manipulator according to claim 1, wherein the manipulator means comprises carbon-containing material.

6. A nano-manipulator according to claim 1, wherein the manipulator means is designed in any appropriate form.

7. A nano-manipulator according to claim 6, wherein the manipulator means are adapted to grab objects having a cross-section between 1nm and 10 μm.

8. A nano-manipulator according to claim 1, wherein the manipulator means are elongated tip element(s) having predetermined length(s) between 100 nm and 100 μm.

9. A nano-manipulator according to claim 8, wherein the elongated tip element define a diameter, the diameter being between 10 nm and 10 μm.

10. A nano-manipulator according to claim 8, wherein the free end of the elongated tip element has a radius of curvature between 1 nm and 10 μm.

11. A nano-manipulator according to claim 1, wherein the manipulator means are adapted to grab objects of any form, such as a form chosen from the group comprising spherical, elliptical, cubic, rectangular, triangular, polyhedral, amorphous, etc.

12. A nano-manipulator according to claim 1, wherein the distance between the first and the second manipulator means is between 1 nm and 20 μm.

13. A nano-manipulator according to claim 3, wherein at least one of the actuation beams is positioned between the first and second beams.

14. A nano-manipulator according to claim 13, wherein actuation forces applied by the at least one actuation beam positioned between the first and second beams decrease the distance between the first and second manipulator means.

15. A nano-manipulator according to claim 1, further comprising a control circuit having electrical connections to the manipulator means, the control circuit being adapted to control electrical measurements being performed by the manipulator means.

16. A nano-manipulator according to claim 1, further comprising positioning means for positioning the manipulator in three dimensions, with respect to a surface or an object to be manipulated.

17. A nano-manipulator according to claim 1, further comprising interface means for controlling the operation of the nano-manipulator.

18. A nano-manipulator according to claim 17, wherein the interface means comprises means chosen from the group comprising keyboards, computer mouse, joysticks, track pads, datagloves, computer input devices, digitisers, digitiser pens, etc.

19. A method of manipulating an object using a nano-manipulator according to claim 1.

20. A method for fabricating a nano-manipulator, the method comprising the steps of:

providing a support,

forming a first and a second beam anchored to the support in at least one point,

placing the first and second beams at low pressure and in the presence of materials to be grown,

forming a first manipulator means by directing a focused particle beam to the first beam to induce growth of the first manipulator means and controlling the thickness, length, and shape of the first manipulator means by controlling one or more predetermined parameters of the particle beam and/or beam moving the particle beam focus in relation to the first beam in a predetermined way,

forming a second manipulator means by directing a focused particle beam to the second beam to induce growth of the second manipulator means and controlling the thickness, length, and shape of the second manipulator means by controlling one or more predetermined parameters of the particle beam and/or moving the particle beam focus in relation to the second beam in a predetermined way,

wherein the materials to be grown at least partly determine the material composition of the first and second manipulator means, wherein the first and/or the second beam are/is flexible between at least a first and a second relative position, and wherein a distance between the first and second manipulator means in the first and the second position are different, and

providing means, held by the nano-manipulator, for moving the first and/or the second beam between at least the first and the second position.

21. A method for fabrication according to claim 20, wherein the means for moving the first and/or the second beam comprises means for applying an actuation force to the first and/or the second beam for moving the first and/or the second beam between the first and the second position.

22. A method for fabrication according to claim 21, wherein actuation force are chosen from the group comprising electrostatic forces, piezoeresistive forces, piezoelectric forces, ferroelectric forces, ferromagnetic forces, thermoelectric forces, electromagnetic forces, etc.

23. A method for performing pick & place operations with nanoscale objects, the method comprising the steps of

providing a member and a nanoscale object to be attached to the member,

providing a nano-manipulator adapted to grip and hold nanoscale objects, the nano-manipulator being movable in relation to the member,

gripping and holding the object with the nano-manipulator,

positioning the object close to or in contact with the member by moving the nano-manipulator holding the nanoscale object,

attaching the object to the member, and

releasing the nano-manipulator's grip on the object.

24. A method for performing pick & place operations according to claim 23, wherein the step of attaching the object to the member comprises the step of inducing material growth joining the object and the member by directing a focused particle beam to a region on the member/object and moving the particle beam focus towards the object/member to join the member and the object together by the grown material.

25. A method for performing pick & place operations according to claim 23, wherein the nano-manipulator is a nano-manipulator according to claim 1.

26. A method for performing pick & place operations according to claim 23, wherein the nano-manipulator is a nano-manipulator fabricated according claim 20.

27. A method for performing pick & place operations according to claim 23, wherein the nanoscale object is a carbon nanotube, a silicon nanowire or any type of semiconducting nanowires, metallic nanowires, or insulating nanowires.

28. A method for performing pick & place operations according to claim 23, wherein the nanoscale object is translated and rotated in relation to the member by holding the nanoscale object with the nano-manipulator and translating and rotating the nano-manipulator in relation to the member.

29. A method for fabricating a second nano-manipulator using a first nano-manipulator, the method comprising the steps of:

providing a support,

forming a first and a second beam anchored to the support in at least one point,

providing a first and a second nanoscale tip element

placing the first and second beams and the first and second tip elements at low pressure and in the presence of materials to be grown,

providing a first nano-manipulator adapted to grip and hold nanoscale objects, the nano-manipulator being movable in relation to the first and second beams,

attaching the first tip element to the first member by

- gripping and holding the first tip element with the first nano-manipulator,
- positioning the first tip element close to or in contact with the first beam by moving the first nano-manipulator holding the tip element,
- inducing material growth joining the first tip element and the first beam by directing a focused particle beam to an anchorage point on the first beam or the first tip element, and
- releasing the grip of the first tip element by the first nano-manipulator,

attaching the second tip element to the second member by

- gripping and holding the second tip element with the first nano-manipulator,
- positioning the second tip element close to or in contact with the second beam by moving the first nano-manipulator holding the tip element,
- inducing material growth joining the second tip element and the second beam by directing a focused particle beam to an anchorage point on the second beam or the second tip element, and
- releasing the grip of the second tip element by the first nano-manipulator,

wherein the first and/or the second beam are/is flexible between at least a first and a second relative position, and wherein a distance between the first and second tip elements in the first and the second position are different, and

providing means, held by the second nano-manipulator, for moving the first and/or the second beam between at least the first and the second position.

30. A method for fabricating a nano-manipulator according to claim 29, wherein at least one of the tip elements is a carbon nanotube, a silicon nanowire or any type of semiconducting nanowires, metallic nanowires, or insulating nanowires.

31. A method for fabricating a nano-manipulator according to claim 29, wherein the tip elements are formed by induced growth in a controlled atmosphere using a focused particle beam.

32. A method for fabrication according to claim 29, wherein the means for moving the first and/or the second beam comprises means for applying an actuation force to the first and/or the second beam for moving the first and/or the second beam between the first and the second position.

33. A method for fabrication according to claim 32, wherein actuation force are chosen from the group comprising electrostatic forces, piezoeresistive forces, piezoelectric forces, ferroelectric forces, ferromagnetic forces, thermoelectric forces, electromagnetic forces, etc.

34. A method for fabrication according to claim 29, wherein the first nano-manipulator is a nano-manipulator according to claim 1.

35. A method for fabrication according to claim 29, wherein the step of inducing material growth joining a tip element and a beam comprises moving the particle beam focus from the beam/tip element towards the tip element/beam to join the beam and the tip element together by the grown material.

36. A method for fabricating a nano-manipulator, the method comprising the steps of:

providing a support,

forming a first and a second beam anchored to the support in at least one point,

providing a first and a second nanoscale tip element

placing the first and second beams and the first and second tip elements at low pressure and in the presence of materials to be grown,

positioning the first tip element close to or in contact with the first beam,

inducing material growth joining the first tip element and the first beam by directing a focused particle beam to an anchorage point on the first beam or the first tip element,

positioning the second tip element and the second beam close to, or in contact with, each other,

inducing material growth joining the second tip element and the second beam by directing a focused particle beam to an anchorage point on the second beam or the second tip element,

wherein the first and/or the second beam are/is flexible between at least a first and a second relative position, and wherein a distance between the first and second tip elements in the first and the second position are different, and

providing means, held by the second nano-manipulator, for moving the first and/or the second beam between at least the first and the second position.

37. A method for fabricating a nano-manipulator according to claim 36, wherein at least one of the tip elements is a carbon nanotube, a silicon nanowire or any type of semiconducting nanowires, metallic nanowires, or insulating nanowires.

38. A method for fabricating a nano-manipulator according to claim 36, wherein the tip elements are formed by induced growth in a controlled atmosphere using a focused particle beam.

39. A method for fabrication according to claim 36, wherein the means for moving the first and/or the second beam comprises means for applying an actuation force to the first and/or the second beam for moving the first and/or the second beam between the first and the second position.

40. A method for fabrication according to claim 39, wherein actuation force are chosen from the group comprising electrostatic forces, piezoeresistive forces, piezoelectric forces, ferroelectric forces, ferromagnetic forces, thermoelectric forces, electromagnetic forces, etc.

41. A method for fabrication according to claim 36, wherein the step of inducing material growth joining a tip element and a beam comprises moving the particle beam focus from

the beam/tip element towards the tip element/beam to join the beam and the tip element together by the grown material.

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